Industrial Robotic Equipment: Presence and Exposure

The Annual Survey of Manufactures (ASM) is a sample survey of approximately 50,000 manufacturing establishments. The survey includes manufacturing establishments with one or more paid employees, including establishments that use leased employees. The 2018 ASM introduced three new questions on the presence and use of industrial robots. In response to growing interest and high demand by industry, policy makers, and researchers, these questions fill a data gap by measuring robotics as part of official government statistics. These measures will allow researchers to understand the relationship between robot adoption and intensity of use, and their impact on employment and productivity. The ASM collects the following information for surveyed manufacturing plants: 1) capital expenditures on industrial robotic equipment, 2) the number of industrial robots present, and 3) the number of industrial robots purchased that year. The new experimental ASM robotics data products address the data gap in robotic use by introducing the following measures:

- National-level estimates of the share of plants using robots and employees exposed to robots.
- Estimates of the share of plants using robots and employees exposed to robots by 3-digit industry, state, and plant size.
- Estimates of the size distribution of plants using and not using robots.

Capital expenditures and robot counts for industrial robotic equipment were collected from establishments that are eligible to be sent the ASM form (the mail stratum). The data are tabulated using the 2017 North American Industry Classification System (NAICS) code assigned to the establishment based on the mail stratum. The 2018 ASM Robotics tabulations use a broad concept of the presence of robotics at a plant described in greater detail below. Plants are identified as having robots present or not. Likewise, employees at plants using robots are considered exposed to robots.

Robot presence was not imputed for plants ineligible to be sent a form (the nonmail stratum). The 2018 ASM Robotics tabulations are therefore representative of the mail stratum of the ASM only (see Annual Survey of Manufactures Methodology (census.gov)).

Definitions

Robot Presence

Plants were classified as having robots based on responses to the robotics questions. Plants that reported positive values for active robots, capital expenditures on robotic equipment, purchases of new robots, or those who indicate in write-in information they have robots but cannot provide details, are classified as having robots present at the plant. Each of the three robotics questions also includes a checkbox “Check if None". This provides an additional way for a respondent to report that they do not have (or use) robotics. Plants that actively affirm not having robots for all questions by selecting all “Check if None” boxes are considered respondents with no robot presence. Respondents that fail to respond to a question or its checkbox, and do not report a positive value in at least one of the questions, are considered for imputation. All estimates are weighted using the 2018 ASM sample weights.

Share of Plants with Robots

Share of plants with robots = Sum (plants with robots in group *i*) / Sum (all plants in group *i*)

where *i* is the 3-digit industry, state, or plant size groupings.

Share of Employees Exposed to Robots

Share of employees exposed to robots = Sum (employees at plants with robots in group *i*) / Sum (employees at all plants in group *i*)

where *i* is the 3-digit industry, state, or plant size groupings.

Industry Demeaned Share of Plants with Robots and Employees Exposed to Robots by State

The industry demeaned share of plants with robots is the share of plants with robots in a state after controlling for differences in industry composition. To compute this measure, we subtract the national industry-level estimates for the share of plants with robots from the state’s share for each industry. This yields, for each industry, the state’s deviation in its industry share relative to the national industry share. We take the mean industry deviations for each state and add to it the national share.

This measure abstracts away from state-level variation in the share of plants with robotics that is simply due to industry composition. A state with more activity in industries that use robotics more intensely will naturally have a higher share of plants with robots. The demeaned measure,

on the other hand, measures the relative intensity of robot use controlling for national, industry-level shares.

Imputation for Missing Data and Survey Nonresponse

Imputation was used to address missing data either due to item or survey nonresponse. Plants with an imputed classification for the presence of robots account for approximately 40% of the mailed sample. Robot users account for roughly 13% of the respondents and 10% of non-respondents after imputation. Numerous regression and machine learning models were considered for the imputation of the presence of robots including logistic propensity scores, random forest, decision trees, and k-neighbor models. Using a 70/30 train/test split, the quality of each imputation model was compared using a Euclidean normalization of the L1 and L2 errors of plant and employee shares in the resulting state and industry tabulations. The model with the lowest composite error was used in the final imputation of the presence of robotics.

Disclosure Avoidance

Disclosure is the release of data that reveals information or permits deduction of information about a particular survey unit through the release of either tables or microdata. Disclosure avoidance is the process used to protect each survey unit's identity and data from disclosure. Using disclosure avoidance procedures, the Census Bureau modifies or removes the characteristics that put information at risk of disclosure. Although it may appear that a table shows information about a specific survey unit, the Census Bureau has taken steps to disguise or suppress a unit's data that may be "at risk" of disclosure while making sure the results are still useful.

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The process of suppression does not usually change the higher-level totals. Values for cells that are not suppressed remain unchanged.

The Census Bureau has reviewed the data product for unauthorized disclosure of confidential information and has approved the disclosure avoidance practices applied. (Approval ID: (CBDRB-FY21-ESMD001-008)